THE TROPICAL RAIN FOREST

AN ECOLOGICAL STUDY

BY

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Chapter I

Introduction

- Tropical Rain forest, ｻｲﾘﾝﾀﾞｰ ﾉ Tree ﾆﾄｯﾃ" climber ﾓ epiphyte ﾓ undergrowth ﾉ shrub ﾓ woody ﾃﾞｱﾘﾃ. herbaceous plants ﾉ epiphyte ﾔ undergrowth = ｽｺｼﾆﾃﾓ relatively = ｽｸﾅｲ, ﾄｲｳｺﾄﾃﾞｱﾙ.
- 木ﾉ大ｷｻ average 46-55m 92 ﾄｲｳﾉﾊ最大 ｻﾝﾄﾓ Sequoia (California) ﾆﾊ 111m, Eucalyptus (Australia) ﾆﾊ 107m, Fagus sylvatica ﾓ 46m ﾄｲｳｼﾀ記録ｶﾞｱﾙ.
- 胸高断面積 per hectare ﾃﾞ 10cm ｲｼﾞｮｳﾉ直径ﾉ木ｶﾞ 40 ｺﾉ位.
- buttress ｶﾞｽｺｼ
  bark ﾊ thin and smooth ﾃﾞｱﾙ.
  leaves ﾊ entire or nearly entire margin
  flower ﾊ inconspicuous, often greenish or whitish ﾃﾞｱﾙ.
- interior of old undisturbed forest ﾊ ﾏﾀｲﾃ = 日ｶｹﾃﾞｲﾀｲ ﾛｶﾞｻﾝﾃｲﾙﾄｷﾉ sun-fleck ｶ floor = ｳｽｸ ｽﾍﾃﾙﾄｺﾛﾃﾞｱﾙ herbaceous ground flora ﾊｽｸﾅｲ. ground ﾊ dead leave ﾃﾞ" thinly = cover ｻﾚﾃｲﾙ, bare soil ｶﾞﾐﾁｮｳﾆｵｵｲﾙ
- climber ｵｵｲ epiphyte ｶﾞｵｵｲ. ｺﾚﾆﾊ 裏ﾆｲﾛｲﾛﾅﾜｹｶﾞｱﾙ.
- 種ﾄﾞﾃﾝｶｽﾞ
  British Guiana ﾆﾃ 8km ﾉ radius ﾉ ﾅｶﾃﾞ = 400 sp. ｲｼﾞｮｳﾉ flowering plants, but far from complete,
  Nigeria (southern) ﾆﾃ. 122m × 122m ﾃﾞ" 70 Dicotyledons, 9 shrubs, 16 green herbs, (ground herbs).

Chapter II

stratification

The tree strata, though always present, are ill-defined and are seldom easy to recognize by casual observation (p.22).

Tree, three strata: shrub, giant herb, ~~tree~~ herb, ferns, palms (12ヒ D層) and ground layer (E層)
(1m high)
↓
苔ヲハジメ herb ヤ tree seedlings ガオホシ.

- 木ノ高サト分布

1. Primary Mixed forest of British Guiana ニテ

A: 35m B: 20m 12ヒ C: 4.6～20 (平均 14m)

オホヨソノ比 A : B : C = 7 : 12 : 49

2. Primary Mixed Dipterocarp forest, Borneo (Mt. Dulit) ニテ

平均 A: 35m B: 18 C: 8

オホヨソ A : B : C = 7 : 48 : 38

3. Primary Mixed forest, Nigeria

平均 ~~Tallest~~ A: 39-46, B: 15-39, C: 15ヨリ下

- 木ノ形

A: crown ガ wider than deep, i.e. umbrella-shaped

B: 〃 deeper than wide

C: 〃 long, tapering, conical; much deeper than wide

- D & E 層

D ガ 4m グライマデ, ground layer 1～2 m high (Borneo ニテ)

D ガ 1m グライ (British Guiana ニテ)

- マレイシア デハ A層ガ 61m マデニモ
- A ガ climatic limit ニ ヨッテ canopy ガ discontinuous ナリ B ガ continuous or discontinuous ナリ C ガ 普通 = more or less continuous デアル
- vertical ニハ Guiana デハ B, C ガ discontinuous, Borneo デハ A, B ガ discontinuous デ B, C ガ continuous, Nigeria デハ 再ビ B, C ガ discontinuous デ A, B ガ サレマデデアル

Chapter 4.

The Physiognomy of the Trees and ~~Ed~~ shrubs.

Ecological morphology of the rain-forest flora.

buttressing
cauliflory) species, systematic position = 10/4 下に

フタリ ヤクバス to some extent ニテ Montane & subtropical Rain forest, ト = ハ 23 m.

ソレラ character ハ ドウシ environment (ecological condition) ノ 10/4 ニ アルカ ショウコ ト.

RSF It does not follow that they are necessarily adaptations in the ordinary sense of the word; indeed, it is questionable whether many of them have great survival value. Some at least are probably related to the environment 'causally', that is to say, they are, in some way not clearly understood, the inevitable result of the action of the habitat factors, any usefulness to the plant they may have being mainly incidental. The morphological characters we are concerned with may be said to be apharmonic, in the original sense of the term (Vesque, 1882), without making any assumptions as to the origin of the 'harmony' between plant and environment.

buttressing ノ ミラレル ノハ A & B strata ニ. tallest ノ キ ニ ミ,
C ニハ キニ ヤヤ ミラレル.

cauliflory ハ C & D (shrub layer) ニ ハ ミラレル.

2

A / 木 / 台 = ついて イエバ ホカノ plant community ニクラベ straightness & thinness ヲ特徴トスル

幹ニ対シテ枝ガ カサイ — lowest branch ノ位置ガ高イ コレノ ナゴタルトキテ botanical garden ナドニ植ワッテモ ハ下カラ 枝ガ出テイル

A 型 crown ハ ホボ umbrella 形 flattened

B 型 crown ハ ソノ半分ノスポメタ形 as deep as they wide

C 〃 Tapering conical スッカリスポメタ形 longer than wide

A 型ノ木ハ C 型ニイルトキハ C 型, B 型ニイルトキハ B 型ヲトッテ 普通ニ A 型ニアイテ Typical ト A 型ヲトルノーニナル.

コノ四ツノ型ノ branching ノスタイルデ A 型ニイウニ木ガ C 型ニイルトキニハ 6-7m ノ高サニ達シテイテモ 若イ last few centimeters ダケニ葉ヲ茂ラセテ, 枝ガカレ上ガッテイルモノデアル.

Bark ハ一般ニカタク, smooth デ, light-coloured デアル. (cork ノ形成ガヨクナイ)

Thorny Trunk ヲ多イガ, コレハ dry climate ニアル tropical forest ヲヨリ多ク特徴ツケルモノデアル.

~~Silted root~~

Stilt root 多クハ C 型ノ木ニ見ラレル.

ヲアシ
竹カマ.

図ニ特徴ヲ切リニシテ Stilt root ヲ強調シヨリサカナガッテリデ

Plank buttresses　A層ノ木ニヲイ.(ハノ) ── B層ニモ見ラレルガ.

stilt roots と plank buttresses と lateral root ノ変形デアル

両者ノ間ニハクリアエキガアリ. 一ツノ木ニ両方ノ見ラレルモアル

(buttress ノ根元ニ地表トノ間ニ空隙ノアルモノアリ)

buttress ハカナリ若木ノトキカラ生ゼハジメル (2~3年カラ5年ゴライ,

木ノ高サデイエバ 3m~8mゴライ) ── ダカ木ガ大キクナリ crown ガ

立ッテイタノヲ上ニヌケトリ見エナクナルマデハナクナイ.

下ノ枝ノツケ根ノ間ニ buttress ヲ生ゼルモアリ.

buttresses ハ表面ニ 3~5 生ゼル.

高サ地上ヨリ 9m ニオイテ最大ナモノサニアル (高サ及ビ水平ニ)

species ニヨリ buttresses ノ大キサ及ビ高サニカガイハアル

(ソシテ巻ノ小サイ木ガ大キナ木ニツイテ水平ヨリモ高サノ方ヲマス)

ソシテ Family ニヨリ, genus ニヨリ. マタ同ジ genus ノ中ノ species ニツイテ

buttress ノデキナイモノモアル (Lauraceae ニデキナイノガ多イ) (Dipterocarpus

や Shorea ニハデキルモノトデキヌモノトガアル)

マタ同ジ species デアルナガラ individual ニツイテ, デキルノトデキナイノトアル.

Mountain Rain forest on tropical mountain デハ buttressing ハ

unseen ヤ uncommon デアル (p. 65) Generally speaking, the

buttressed habit is absent in temperate forests (p. 66).

4 p. 226 ... Where the soil is actually shallow or, owing to a high water-table, 'effectively' shallow, the root systems tend to be superficial and buttressing is common.

Buttressing and soil conditions

more porous + sand ガチな土では ニオイテ. 根ガ ジカニ ヒロガルノヲ サケテ buttress ガ発ダツ swamp or waterlogged silt ノトコロデハ サイ生 condition ノモトニ buttress ガ発ダツスルノガ ーバルノヨーダ. (stilt root ガ mangroove ト呼ビナイデハルケレドモ 気ニスルヨ)

日本ハ 'phisiological' ナイケド 'physically' = 土ガ弱イ steep, stony hillside ヤ ridge ニハ タクサン buttress ガ発ダツシテ木ガ生エル

tropical tree ノ root system ノ shallowness ハ一般的ニイッテ水ヤ salts ノメデタク. 酸素ヲ含ンデイルトモタク Oxygen = 好気性モノデアリ competition ガアルトスレバ, ソレ Oxygen = 関スル competition デアル (p. 68).

ソシテ buttress ノデキル木ハイズレモ large, superficial lateral root ヲモッテ木デアリ ソレト soil ノ poor aeriation, poor effective depth for root 及ビ raf-root ノ支持トイッタコトトノ correlation ガ考エラレテヰル.

(ソレニ lateral root ガ 20m モノバシテイル木デ unbuttress ノモノモアル)

Theories of buttress formation

1) The adaptation theory ソレハ支持ト考エテイル

ソレニヨレバ buttress ノナイ木ハ natural selection デ eliminate サレテシマイ, ソコデ buttress ノ mechanical support ヲ考メコートモ. マタ ソレカラ, モット風ノ強クアタル Temperate region ニモ buttress ガ発ダツシナイノモ, マタ Tropical tree ハ buttress ノ他ニ lianes = ヨッテモ支エラレテイルトコロガアル

buttress が suffrat に見られるという. soft soil よりは hard soil のところで, その風あたりの強いところでは低いものほど buttress が発達しやすい. firm clays and loam, ところでは loose sandy soil では buttress をもつものが少ない. 風力 = buttress をもつものが多いという. buttressed tree と unbuttressed tree とを引き抜くに要する力の比較をしている.

~~2) The negative geotropism theory~~

~~3) The conduction current theory~~

などについて, buttress が風あたりの強いところに多く発達するという説を否定している. この buttress は支持 C 役をするが, 風あたりの強いところでは役をしない. むしろ strain になる. buttress が支持のために発達するという説を否定している.

Shrub stratum

Temperate のところでは shrub という life form のものが少ない. dwarf tree (Dwarf trees) undranched で, top が芽がアスパラガスのようになっている. The close resemblance in general form between these species and young individuals of true trees tempts one to regard them from an evolutionary point of view as precociously reproducing trees (p.76).

Buds

Raunkiaer ('34) ノ分類ハ

i) evergreen phanerophytes without bud-covering

ii) evergreen phanerophytes with bud-covering

iii) deciduous phanerophyte

ノウチデ constantly hot & humid Tropical Rain forest カラ less constantly moist & subtropical region ヘ移行スルニツレテ ii) ノ型ノ植物ガ モノヲ乾燥カラ保護スル protected bud ガ全ク存在シナイトイウワケデハナイ ソレニ Java ノ rain forest デモ temperate ゾーニ ノ落葉樹 Quercus ハ dry bud-scales ヲモッテイル,

Young Leaves

○ red-coloured young leaves ガ多イ (色ヲツケテイルト光線ヲヨク反射スルノデ温度ガ上ガラナイ)

コレニハ葉ノ中ノ temperature ヲアゲテ rate of transpiration ヲマスト共ニ紅葉ト ultra-violet light ノ吸収ヲスルトイウ意味モアッテイルガ, buttressing ト同ジ様ニ genus ニモ species ニモ ソレホド young leaves ノ赤イノガナイ (p.79) West Africa デハ全ク赤クナイ

○ 葉ガ expand シテモ, 若イ葉ノママデアッテイテ, コノヨウニナイト stiff ニナラナイトイウノモ tropical rain forest tree ニヨクミラレル特徴デアル

コレラハ all strata ニアラワレル

ソノコトモ乾燥ニ対スル adaptive カモシレナイガ, more rigorous environment デハ harmful + character ガ, コノ点デ 'unpunish' トイウモノモアル (p.80)

Leaf size and shape

○ sclerophylls ノ, 'mesophyll' size-class ノ葉ガ多イ

ソレハ Warming ニヨレバ 'laurel type' デアル (地中海沿岸ノ, 'myrtle type — 葉ハモットセマイ — デハナイ)

○ mesophyll ノ ヨイフトハ Fig 15 ヲミヨ (p.83)

Nigeria :	Wet Evergreen forest	mesophyll	84%
Trinidad :	Evergreen Seasonal forest ("Emergent" trees)	〃	86
Trinidad :	Evergreen Seasonal forest lower story	〃	80
Philippine :	Tropical Rain forest (Dipterocarp)	〃	86
Mt. Maquiling (Brown '19) Philippine :	Submontane Rain forest (Quercus-Neolitsea) 700 m	〃	87
Philippine :	Montane (Mossy) Rain forest	〃	50
		Microphyll	50

! Microphyll ノ 50 ++= Entire margin ノ 多イハ

○ A, B 型ノ木ノ葉ハ smaller, thicker, more leathery in texture ナル

○ the type of leaf apex

C : longly acuminate
B : shorter acumen or none at all
A : no acumen or only a short, ill-defined one

○ A story ノ木ノ葉ニハ juvenile ノトキハ長クテ drip-tip ヲモツケレド, adult ニナルト葉ガカワッテ drip-tip ノナイモノニナル (Fig 16, p.86) ノモ = juvenile ノトキハ ~~dis~~ deeply incised シテイテ adult デ entire ニナル, juvenile ノトキハ 3-5 leaflet ヲモツ羽状複葉ノモノガ adult ニナルト single leaflet ニナッテシマウモノアル.

drip-tip ノ効用 雨ノ多イ熱帯ノ森ノ中デハ葉ノ表面ニ水ノ膜ガ張ッテシマウト光合成ガ出来ナクナッテシマウ. (葉ノ表面ニ water-film ガ出来ルト炭酸ガスガ入リニククナルカラ photosynthesis ガ出来ナクナッテシマウ) ソコデ same species デモ dry zone ニアルモノニハ drip-tip ガ発達シテイナイ. environmental テキニ ~~ル~~ ナッテイル

cauliflory : its production of flowers or fruits on woody stems, e.g. cacao, Theobroma cacao, a small tree in the rain forest of tropical America.

main trunk や thick branch など：その表面から直接 flowers や fruits が生じる shoots を生じる。smaller branch や crown などの aerial vegetative shoots は生じない。

A, B 図 : cauliflory を示す木。C 図 : 枝の epicormic shoot が C 図のように elimination されるまで 3 年 ~ 4 年かかる。

Evolution : 花や果実は、その branch 上に多数つくため、pollinator や seed dispersal agent にとって — 花や果実が constant な場所にあるため、both pollination and seed dispersal が efficient である。

また seed dispersal の際 family 内の種間競争を避けることができる。

mistletoe による dispersal

primary rain forest の over-canopy emergent species に bird-dispersed fruits を produce する mistletoe が多い。

top story の trees は wind dispersed seeds (winged fruits など) を produce する。

top story の wind-dispersed trees や top story より下の understory trees の wind-dispersed seeds は、heavy fruits などを produce する。

Chapter V

climbers, tall trees, Temperate, etc. 'mixed' crown, etc. 'mixed' crown
of 2 or 3 species. The less regular the space between crowns, the more
the gaps, and the more light reaches the shade leaves. shade leaves
tend to be thinner, leaf size is 'mesophyll' type. If 'normal' light
strikes the shade leaves, it is different type of leaf.

dimorphism of shade leaves and sun leaves (heterophylly)

Trees alone in shade tend to have broad crowns, sun leaves are
small, smooth, rectangular leaves, soft texture with
a velvet surface, or deeply serrated, sclerotic, tough, glossy ones,
acrophylla (sun leaves), convergence between
both types of shade leaves, but different modes in different species.
In young leaves, old leaves are

Canopy trees, the percentage

Stranglers

epiphyte, independent (or almost so) plant
substrate, tree

hemi-epiphyte, mechanically self-
supporting

(eg. Ficus spp. (Africa, Indo-Malaya, Australia))

Epiphytes

Trunk, branch, leaves [illegible]

relatively high light demand [illegible]

[illegible] Cactaceae [illegible] semi-desert [illegible]

[illegible] savanna [illegible]

[illegible]

[illegible])

[illegible] arboreal ants [illegible] nesting place [illegible]

[illegible] mosquitoes (malaria carriers) [illegible]

[illegible] Tropical rain forest [illegible] ground [illegible]

[illegible]

[illegible] some [illegible]

[illegible]

[illegible] epiphytes [illegible] tropical Rain forest [illegible]

[illegible]

[illegible]

[illegible] epiphytes [illegible] tropical Africa [illegible] poorest [illegible] Africa [illegible]

[illegible] longer and more [illegible] dry season [illegible]

epiphytic [illegible]

[illegible] mineral nutrients [illegible] water [illegible]

[illegible] water [illegible]

[illegible] (Rain forest [illegible]

[illegible] Illumination [illegible] lower & more variable

[illegible] atmospheric humidity [illegible])

Schimper's forms of plants ... long shoot ... normal tree ... epiphyte ... dependent tree ...

Stem-varieties of ...

rain forest ... forest floor ... mosses, lichens, liverworts and algae ... aquatic ... dead leaf ... rotting effect ... rock ... fallen logs ...

... A, B ... shade epiphytes ... flowering plants ... forest ...

... West European forest ... deciduous forest ... swampy places ... long-lived, tough leaves ... parasite ...

Saprophyte

... forest floor ... intense shade ... slight drying ...

parasite

parasitic flowering plants ... rain forest ... surrounding ...

semi-parasite ... Loranthaceae ... A, B ... twig ... branch ... host, leaves = parasite ... leaves ...

[illegible]

○ dry season [illegible] wet season [illegible] maximum [illegible]
wet season [illegible] dry season [illegible] minimum [illegible]
(p.200)

○ season [illegible]
(p.20)

○ [illegible] internal [illegible]
[illegible] shrubs [illegible]
[illegible] (p.201)

○ [illegible] Some [illegible] Orna [illegible] avoid
six [illegible] (p.201) [illegible]
[illegible] external [illegible] internal [illegible]

[illegible] grasses flowers [illegible] mid dual [illegible]
[illegible] (after [illegible] Nainya [illegible]) [illegible]
[illegible] internal [illegible]
(pp.201-203).

Chapter 9

Soil conditions

- general characteristics of tropical red-yellow, [illegible] clayey [illegible] plant nutrient [illegible], acid, humus content [illegible] (p. [illegible])
- [illegible] groundwater [illegible] flowing slowly moving sheet of water [illegible] (p. 207)
- [illegible] nature soil of the rainforest region [illegible] leaching [illegible] leaching zone [illegible] (p. 208)
- [illegible] soil [illegible] contains rainforest soil [illegible] in arid [illegible] (p. 208)
- Since the leaching of bases and other plant nutrients is more rapid than the leaching of silica, the more mature a tropical soil, the [illegible] as a rule, is its fertility and agricultural productivity.

The [illegible] leaching of silica from a soil is called laterization. The chief process [illegible] of iron oxides* in iron and aluminium with the accumulation of [illegible] is called podzolization. This is the typical soil forming process of cool [illegible] climates, though under certain conditions it can also occur in the tropical rainforest. (p. 208)

* Fe_2O_3 Al_2O_3 [illegible]

Tropical red earths.

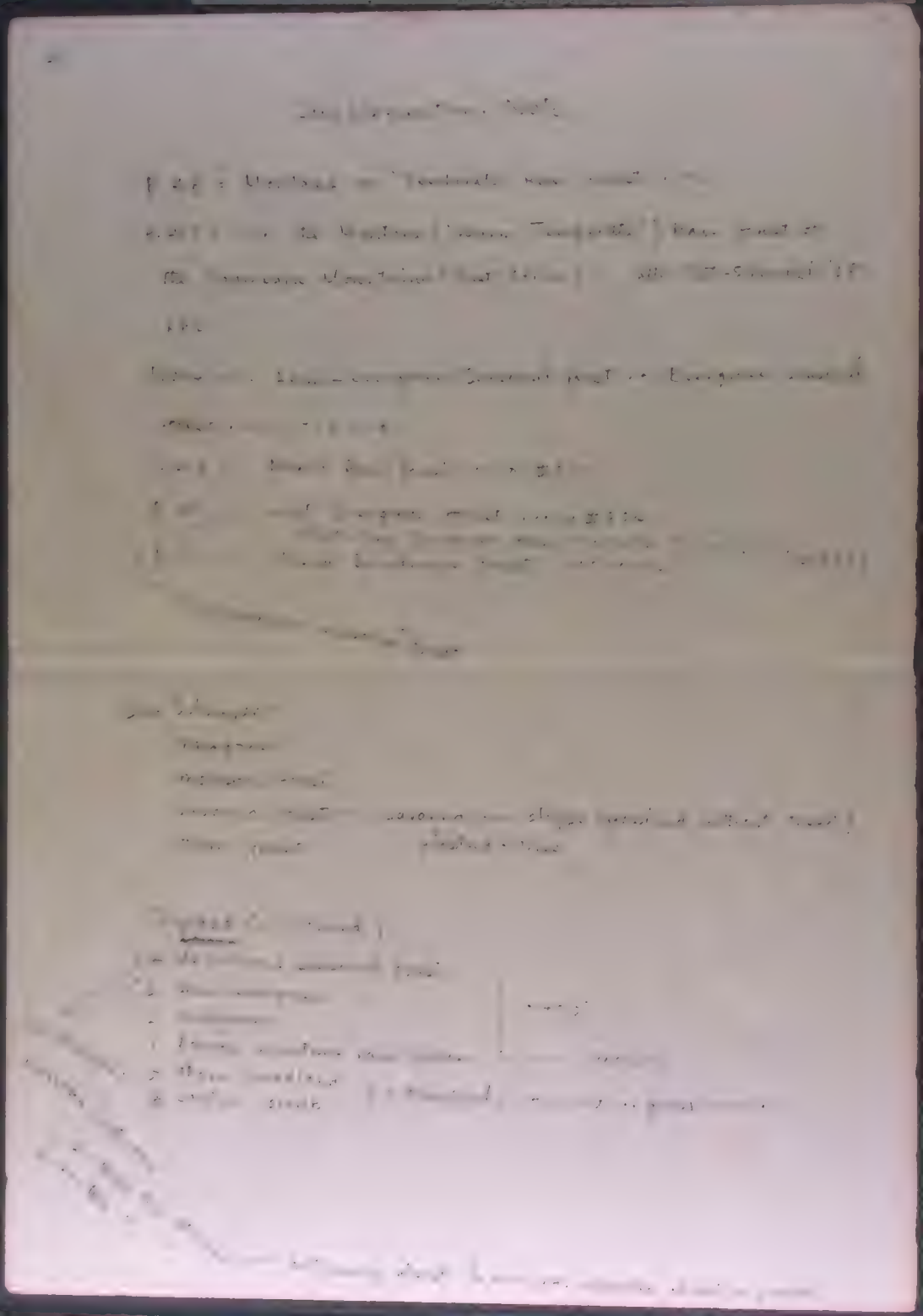
- The term laterite may be applied to the end-result of laterization — a mixture of alumina and iron oxides with very little silica. ... Though true laterite is probably not found under rain-forest conditions, many, probably most, forest soils of the damp Tropics are lateritic. (p. 209)

- The red colour common in Tropical soils formed under conditions of unimpeded drainage is due to the abundance of iron oxides. ... The whole class of Tropical soils with a red colour and showing some degree of laterization is known as the Tropical red earths. (p. 209)

- Lateritic red earths may be the most widespread soil type of the rain-forest region, but by no means all Tropical soils are lateritic. [illegible] sandstone, some acid igneous and metamorphic rock [illegible] is highly siliceous [illegible] the de-silicification characteristic of lateritic soil is indefinitely postponed. [illegible] Sedimentary clays [illegible] lateritic soils [illegible]. Lateritic weathering with the production of Typical Tropical red earths is best seen on fragmental volcanic rocks (p. 210)

- humus Top 10cm = accumulate zone, slow rapid decomposition [illegible] = humus of rain-forest soils of the red or yellow earth type [illegible] normally not very acid in reaction [illegible] (p. 215).

- humus + laterization process [illegible] soil fertility [illegible] (p. 219)



p. 343 "... under the humid evergreen vegetation is considered the natural one, it may be supposed that there would be a wide gradual transition from the wet evergreen and semi-evergreen forest zone to the lower, mainly deciduous, forest-clairs and miombo; there would be no open grassy savanna. This is referring to the major boundary between open savanna forest and open savanna.

" ... a deciduous forest, rather open, but with a mainly woody understorey, and scattered patches rather than a continuous cover of grasses (forêt claire tropicale or Longréville; Closed Savanna woodland of Jones & Keay, 1961). The dominance of grasses in the existing vegetation is unquestionably a result of burning. ... (p. 342)

"... miombo (Brachystegia – Isoberlinia) woodland of southern and eastern tropical Africa ... (p. 330)

Savannas of the Congo forest region

p. 344 Ecosia are pockets of savanna of small extent a typical example ... Coquilhatville covering about 3 ha, – situated in the most low-lying part of the central basin, usually near rivers, and never on plateaux or mountains. The flora of these ecosia is very uniform, the dominant plant is the grass Hyparrhenia diplandra, with which are associated various other herbaceous plants, bushes and stunted trees. Usually the ecosia occupy old river sandbanks which have been left dry and become attached to the land by the shifting of the stream. The ecosia are not forest and Keays regards some of them as 'natural' savannas in which edaphic factors prevent the normal growth of trees, ...

Conclusion

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On the whole it seems likely that moist soil conditions are not unfavorable to the growth of trees and the natural vegetation is not subject to permanent check. The Tropical Rain forest always gives place at its climatic limit to Deciduous forest and this to Savanna woodland, while at the further increase in the dryness of the climate Savanna woodland in its turn is replaced by Thorn woodland and desert vegetation.

Vain rows of Deciduous forest [illegible] gradually, striking or sudden change of physiognomy [illegible]

D 345

"Savannas in which trees are dominant (with or without a continuous ground-cover of grasses) may be a climatic climax, but many types of savanna should be regarded as fire-climaxes. ... Many savannas, with trees growing scattered or in occasional clumps, and tree-less grasslands may arise by the degradation of forest or savanna woodland by excessive cultivation or burning, but in some cases they are probably edaphic climaxes due to local soil conditions unfavourable to the growth of trees. The nature of the factors responsible is uncertain but one which probably operates in some cases is seasonal water-logging alternating with dry conditions during the rest of the year. There is little support for the view that lowland Tropical grasslands are ever a climatic climax in equilibrium with a 'Tropical grassland climate'; grassland therefore should not be regarded as occupying a place in the natural climatic sequence from Tropical Rain forest to desert.

Chapter 5

The Tropical Rain Forest of the Old World
and what it is not

The [illegible] Tropical Rain Forest is left behind and is replaced by a mountain forest in which many of the genera are common to the Indian, and Tropical Rain Forest proper, but which is a somewhat different kind of forest which it is convenient to call the Submontane Rain Forest. This is a still higher division of the Tropical Rain Forest, the Montane Rain Forest.

Submontane and Montane Rain Forest are not always clearly distinguished and may be treated together as Tropical Montane Rain Forest, but it is convenient to restrict the name Montane Rain Forest to the [illegible]

From the Tropical Montane Rain Forest it is a short step to the Temperate Rain Forest of the major zones of vegetation on earth.

Table showing zones of vegetation on Mountains

Zones on mountains (in Tropics only)		Zones of vegetation determined by the climate
[illegible]	Alpine zone	Alpine vegetation
[illegible]	Upper forest zone	Temperate Rain Forest or Deciduous Forest
[illegible]	Montane zone	Montane Rain Forest
[illegible]	Submontane sub-zone	
[illegible]	Hollow sub-zone	Tropical Rain Forest
[illegible]	Lowland sub-zone	

Zonation on the west ridge of Kinabalu (pp 304–305).

Climatic Tree Limit is reached at 4200 m. or higher (p 357).

V.	High Montane forest 3000 – 3350 m. (?)	... richer and less mixed, climatic, temperature ... ... climatic ...
VI	Mossy forest 2250 m. (?)	Montane Rain forest ... single ... Podocarpus, ... tree ferns, ...
iii	Mid montane forest 1050 – 2250 m	... dwarf ... – ... ... cash-crops ... Araucaria ... buttressed ...
ii	Hot hills forest 300 – ... m	... Oak ... dominant ... ... except towards ... ...
i	... ...	... ...

... p 352 ... The ... Rain forest ... the lower slopes of the mountains ... the climax ... m, ... gives place to Foothills forest, ... This is the information which is available about the latter, ... suggests that it should be regarded as an ... formation, ... with the Mid-montane Rain forest of the ... (p. 351), ... the term Sub-montane Rain ... can be provisionally applied to it, ... forest ... montane ... forest (Montane Rain forest) ... (Brown (1919), Vt. Merrill. (1923), ... (pp 352–357)

Zonation on the ... mountains of Malaysia

IV	Mossy forest ...	... average 6m ... Single stemmed, ... 3m ... height of tallest Tree; ... ...

... Mid-montane ...

iii Mid-mountain forest zone 600–900 m — mixed evergreen community, two storied, highest 22, average A 17, B 4, Quercus ブナ科, climbers numerous, ~~epiphyte abundant~~ mesophyll

ii Dipterocarp forest zone 200–600 m — mixed evergreen, three storied, highest 36 m, average A 26, B 16, C 10 m, liana very abundant, buttressing and cauliflory well developed, mesophyll dominant

i Parang zone 0–200 — ニレ科 secondary ヤエテ. Richard, シラヌイ Borneo, Mt. Dulit ニレ科 (p. 356)

ii. Mt. Dulit ヲカ

iii Montane forest — mossy, two storied, not one storied

ii probably Mid-mountain forest, 450–970 or 1100 m

i Dipterocarp forest, 0–450 m

p. 356 Symington (1936, 1943) ヨリ low land, Dipterocarp forest ~ 1200 m マデ ヌケ ナシ, ソレ ナラ = ヨリ フカクニ

		dominant species
iii	High Hill Dipterocarp forest	Shorea platyclados, S. ciliata
ii	Hill Dipterocarp forest	Shorea curtisii
i	Lowland Dipterocarp forest	shorea spp. of the 'red meranti group'

ソレ, mountain forest ガ ヌケ ニレ = ソダツ ~ 2200 m Dipterocarp ~ usually not present ヲカ

ii	Mountain Ericaceous forest	
i	Mountain Oak forest	1500–1800 m マデ

p. 356 Symington's three sub-zones of Dipterocarp forest clearly belong to the Tropical Rain forest formation; the Mountain Oak forests, which are similar to the Foothills forest of New Guinea and the Mid-mountain forest of Mt. Maguiling, represent the formation here termed Submontane Rain forest. The Mountain Ericaceous forest is similar to the Montane Rain forest of other Malaysian mountains.

p. 357. West Java ニテ three zones ヲ認メラレテヰル. Tropical Rain forest ハ 1500–2200m ニテ oak (Castanopsis ノ一種) ガ dominant + Temperate Rain forest ニ移リ, ソレヨリ上ニ Mist forest (Elfin Woodland) ガ現ハレテヰル. 之ハ dwarf Mossy forest ト一致ス

p. 358 Congo ニツキ Lebrun (1935, Pl I) ノ言フ所

iii Montane Rain forest zone — lower limit 1650–1750m upper limit 2300–3400m
ii Transition forest zone — " 1100–1300 " 1650–1750
i Tropical Rain forest zone — " 1100–1300

p. 358 The upper limit of the Montane Rain forest, which coincides with the level of maximum precipitation, is marked by the beginning of the very characteristic Bamboo zone (lower limit 2200–2400m, upper limit 2600m), formed by a very dense consociation of Arundinaria alpina, which is met with on most of the higher East African mountains. Above 2600m. the Bamboo zone is succeeded by the Ericaceae zone (lower limit 2600–3100m, upper limit 3700–3800m), dominated by arborescent species of Erica and Philippia, or (especially in the eastern group of the Virunga Mountains) by a Hagenia zone (2600–3100m), a type of dwarf open woodland; finally come the Alpine zone, the chief home of the arborescent senecios and lobelias (lower limit 3700–3800m., upper limit 4600m), and the zone of permanent snow.

p. 359 ~~Montane Rain~~ Transition forest ハ two storied, average height 25m. Montane Rain forest ハ average height 20m, the great majority of the Trees are evergreen, only four buttressed, lianes ヲヤヽ, epiphyte ヲ含ム

P. 360 Lebrun ハ Montane Rain forest ヲ三ツニ = Lower, Middle, Upper ニワケテヰル. Podocarpus ハ Middle ニヲヽヲヽシイ. 此ノ subzone ニハ Usnea ハ not conspicuous デアル.

Chapter 17
Secondary and Deflected Successions

Secondary forest ㄱ 숲 ㅅ 성

○ p. 379 Seen from above it has a more level 'surface' than primary forest. For example, the young secondary forest 'fallow' in the cultivated area of the Tinjar valley in Borneo looks like a smooth lawn when seen from Mt Dulit 1200 m. above; in the more darkly coloured primary forest the crowns of individual trees can be distinguished at a much greater distance.

○ p. 381 Singapore ㅇㅅㅌ ㄱ. In the secondary forest the families represented by the greatest number of species were Euphorbiaceae and Urticaceae. ···, ~~Malaya ㅇㅅ~~ ㄱ. The Dipterocarpaceae, so characteristic of the Malayan climax forest, were entirely absent in this secondary forest. ···

p. 380 ㅅ ㅌ = secondary forest ㅅ dominants ㅇ primary forest = 2 종 ㅅㅅ ㅅ ㅋㅎ ㅇㅅ ㅅㅅ ㅅㅌ. ㅋㅎ ㅇㅅ secondary forest ㅅ ㅅ 포 ㅍㅍ ㅈ species ㅅㅋㅌ ㅋㅎ ㅇㅅ ㅍㅅㅅㅌ

○ 숲 성 ㅅ 성 ㅅㅌ

p. 381 ··· the secondary forests of the Ivory Coast consist of about thirty species of trees and the 'virgin' forest of 250–300. (ㅇㅌ ㅅ 250–300 ㅅㅋ ㅍㅍ ㅅ serious underestimation ㅇㅅ Richards ㅅㅋ)

Secondary forest tree ㅅ characteristics

1. 생ㅈ ㅅ 초 ㅂ 종 ㅅ light-demanding species ㅈ shade ㅅ 적 ㅈ ㅅ ∴ 그 종 ㅈ ㅋㅋ ㅅ ㅂㅈ ㅈ regenerate ㅈ ㅎ 2 (p. 382)
2. efficient dispersal enables them to colonize openings and clearings as soon as they are made (p. 382). ㅅ ㅎ ㅈ wind + bird ㅇ ㅅ dispersal ㅇ 중 ㅇ. ~~Symington ㅅㅋㅌ~~ secondary forest species ㅅ dormant seeds ㅅ primary forest ㅅ surface soil ㅇ 적 ㅈ ㅇㅅ 적 ㅋㅎ ㅅ (g. 15 ㅅ). ㅌ Symington ㅅㅋㅋ (p. 383)

3. イズレニシテモ，コノタメニハ 苗木 ガ タクサン ツクリ，ソノ 苗木 ガ 生長 シテ イル トイウ コトガ 大切 ニナッテ クル デアロウ (p. 383)

4. Quick growth enables the species of the earlier stages of the succession to establish themselves before they are shaded out ... (p. 382)

ココデ 2年 ハ 8m，アルイハ 3年 ハ 11m ノ タカサ ニ ナル second-growth ノ tree species ガ Malaya デ オオイ ノデアル。(p. 383)

5. In general secondary forest trees are short-lived, maturing and reproducing early (p. 385)

6. timber ガ soft texture デアル トイウ コトモ，ソノ rapid growth ノ ヒトツノ 特徴 デアル secondary forest trees ノ 大切ナ ノ

7. secondary trees ノ leaves ハ 色ガ paler (primary forest trees ニ比ベ) テ，divided or non-entire leaves ニナル 傾向 ガアリ，leaf size モ less uniform デアル

8. ヒトツ ノ secondary forest ~~tree~~ species ガ primary forest ノ ソレト ニ distribution ノ 上デ ドノヨウナ 関係 ガアルカ ニツイテハ ノチホド pan-Tropical デアル

Secondary successions in Africa

p. 389 In every area studied Musanga cecropioides* has become dominant after about three years. コノ木 ハ stilt-rooted デアル

After 15–20 years the Musanga trees die. ~~ソレハ 45–80年~~

* the most abundant and characteristic secondary rain-forest species of tropical Africa. ~~Non-consocial~~ ソレニモ single-dominant forest ヲ ツクル

p. 391 Musanga stage ノ ヒトツ 45–80年 ノチニ primary forest tree ガ dominant トナッテ イク

p. 391 Imperata grassland (~~Imperata~~ Imperata cylindrica). コレハ deflected succession ノ ヒトツデ 一度 cultivate シタ土地ヲ ソノママ ホウッテオクト ヨク normal secondary succession デ アラワレル コノヨウナ 状態ヲ cultivate スルト，ソノアトニハ イツマデモ suppress サレテイル Imperata ガ ハビコッテ，pure consocies ヲ ツクリ，biotic climax トシテ イツマデモ persist スルコトガ アル。ソノ原因(Imperata = ヨシ) ハ Africa ト ヒトシク Malaya ニモ ミラレル。